The exhaust port pressure threshold, $P_{exhaust\_port\_thresh}$, is calculated as the pseudo code below indicates.

If $P_{increase}<1$

Then $P_{exhaust\_port\_thresh}=7.35+PEEP+P_{exh}*0.03$ (Eq. 11)

Else $P_{exhaust\_port\_thresh}=P_{increase}+PEEP+P_{exh}*0.03+6.35$ (Eq 12)

where $P_{exhaust\_port\_thresh}$ has an upper bound of 100 $cmH_2O$.

The exhalation pressure sensor measurement, $P_{exh}$, is compared to $P_{exhaust\_port\_thresh}$. If $P_{exh}>P_{exhaust\_port\_thresh}$ for 100 consecutive milliseconds, and 200 msec have elapsed in the exhalation phase, a severe occlusion alarm is annunciated and ventilation switches to the occlusion status cycling mode. It is commonly difficult to detect this type of occlusion during inspiration, and this mode of occlusion detection is disabled during exhalation pauses.

The maximum flow delivered from the ventilator is dependent upon patient type. The maximum flow limits (Flow_cmd_limit) for adult and pediatric patients are typically 200 and 80 lpm, respectively.

In a presently preferred embodiment, concurrently with the declaration of severe occlusion or the detection of exhalation exhaust port occlusion, the invention provides for a pressure-based occlusion status cycling mode. Occlusion status cycling serves two objectives: 1) protecting the patient from over distension while attempting to ensure that the patient receives some ventilation, and 2) monitoring the inspiratory and expiratory phases to determine if the severe occlusion abates. As occlusion status cycling ensues, the severe occlusion may relax to either a partial or a normal state. If an occlusion does abate, it must qualify as less than a severe before the ventilator system will revert to settings in effect prior to the patient tubing system occlusion. During occlusion status cycling, a purge flow is not to be established.

Referring to FIG. 2, the flow chart depicts the sequence of events that must be performed for the implementation of occlusion status cycling. Five phases of occlusion status cycling have been defined for the purpose of flow charting.

Phase 1: An exhalation phase in which the ventilator closes the pressure solenoid valves, controls the expiratory valve to zero PEEP, discontinues flow triggering, sets PEEP equal to zero, sets the breathing gas oxygen percentage to 100, and opens the safety valve. This shut-down state persists until $P_{insp}\leqq 5$ $cmH_2O$ or until 15 seconds have elapsed, whichever occurs first. This phase is typically entered if an occlusion is detected while ventilating with normal settings.

Phase 2: An inspiration phase, in which at the beginning the ventilator closes the safety valve. After the 500 msec have elapsed, to allow for safety valve closure, the ventilator system delivers a Pressure Controlled Ventilation (PCV) based breath with an inspiratory pressure target of 15 $cmH_2O$, a flow acceleration percent of 100, an inspiratory time of (2500–500) msec., and using $P_{insp}$ as the feedback signal for control.

Phase 3: An exhalation phase, in which the ventilator closes the pressure solenoid valves and controls the exhalation valve to zero PEEP. Exhalation will last until ($P_{insp}\leqq 5$ $cmH_2O$ AND at least 2.5 sec have passed) OR a total of 5 seconds have elapsed since the beginning of the exhalation.

Phase 4: An exhalation phase, in which the ventilator closes the pressure solenoid valves, controls the exhalation valve to zero PEEP and opens the safety valve. Exhalation will last until ($P_{insp}<5$ $cmH_2O$ AND at least 2.5 sec have passed) OR a total of 5 secs. have elapsed since the beginning of the exhalation



Phase 5: An inspiration phase with current mandatory settings, the only exception being PEEP which remains at zero. $P_{exh}$ is used as the feedback signal for control purposes if the breathing algorithm is pressure based.

It will be apparent from the foregoing that while particular forms of the invention have been illustrated and described, various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited, except as by the appended claims.

What is claimed is:

1. A method for detecting disconnection and occlusion of a patient tubing system of a pneumatically driven, electronically controlled ventilator system for providing breathing gas to a patient during the exhalation phase of a breath cycle, said exhalation phase having a plurality of control intervals, comprising the steps of:

delivering a flow of breathing gas to a patient during an inspiratory phase of a breath cycle;

determining an onset of an exhalation phase of said breath cycle;

suspending gas flow delivery to the patient tubing system during said exhalation phase of said breath cycle;

monitoring exhalation flow and pressure in the patient tubing system during a plurality of control intervals of said exhalation phase of said breath cycle to determine whether a condition indicating disconnection of the patient tubing system has occurred;

monitoring exhalation pressure in the patient tubing system during a plurality of control intervals of said exhalation phase of said breath cycle to determine whether a condition indicating occlusion of the patient tubing system has occurred; and

generating a disconnection signal indicating disconnection of the patient tubing system responsive to said exhalation flow and said pressure in said patient tubing system if said condition indicating occlusion of the patient tubing system has not occurred, and if said condition indicating disconnection of the patient tubing system has occurred.

2. The method of claim 1, wherein said tubing system includes an exhalation line, and said step of monitoring exhalation flow and pressure in the patient tubing system comprises sensing pressure and flow in said exhalation line, and declaring disconnection of the patient tubing system has occurred if, during a control interval, the pressure in the exhalation line is less than or greater than a predetermined pressure range, and if exhalation flow is less than a predetermined flow threshold, for a contiguous period of consecutive control intervals within a predetermined initial period of time following onset of an exhalation phase.

3. The method of claim 1, wherein said tubing system includes an exhalation line, and said step of monitoring exhalation flow and pressure in the patient tubing system comprises sensing pressure and flow in said exhalation line, and declaring disconnection of the patient tubing system has occurred if, during a control interval, the pressure in the exhalation line is less than or greater than a predetermined pressure range, and if exhalation flow is less than a disconnection flow limit threshold based upon a flow target and a predetermined disconnection sensitivity, for a contiguous period of consecutive control intervals within a predetermined initial period of time following onset of an exhalation phase.

4. The method of claim 1, wherein said tubing system includes an exhalation line, and said step of monitoring

exhalation flow and pressure in the patient tubing system comprises sensing flow in said exhalation line, and declaring disconnection of the patient tubing system has occurred if a desired flow target is greater than or equal to a maximum flow threshold, and the duration of a current inspiration is greater than or equal to a maximum allowed spontaneous inspiration time.

5. The method of claim 1, wherein said tubing system includes an exhalation line, and said step of monitoring exhalation flow and pressure in the patient tubing system comprises sensing flow in said exhalation line from the beginning of an inspiration to the beginning of an exhalation, determining an exhalation volume from the sensed flow from the beginning of the inspiration to the beginning of the exhalation, and declaring disconnection of the patient tubing system has occurred if the exhalation volume is less than the integral of the net flow from the beginning of inspiration to the beginning of exhalation with respect to time, multiplied by a proportional factor and a disconnection sensitivity factor, for three consecutive breaths.

6. The method of claim 1, wherein said tubing system includes an exhalation line and an inhalation line, and wherein said step of monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises sensing pressure in said exhalation line, sensing pressure in said inhalation line, determining a pressure drop by comparing pressure in said exhalation line and pressure in said inhalation line, and generating an alarm indicating occlusion if said pressure drop exceeds a predetermined pressure drop threshold.

7. The method of claim 6, further including the step of adjusting said pressure drop for a pressure offset and a gain drift.

8. The method of claim 6, wherein said ventilator system includes a plurality of counters, each of said counters having a different limit corresponding to a different respective pressure drop range, said step of monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprising comparing said pressure drop and said pressure drop threshold in a plurality of consecutive control intervals, and incrementing each of said plurality of counters if the pressure drop is greater than the corresponding pressure range of the plurality of counters, respectively, and generating an alarm if the respective limits of any of said plurality of counters are exceeded.

9. The method of claim 1, wherein said control intervals have a predetermined duration.

10. The method of claim 1, wherein said tubing system includes an exhalation compartment, and wherein said step of monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises sensing pressure in said exhalation compartment, and generating an alarm indicating occlusion if said pressure in said exhalation compartment exceeds a predetermined exhaust port threshold pressure for a predetermined number of consecutive control intervals within a predetermined period of time during an exhalation phase.

11. The method of claim 1, further comprising the step of generating an occlusion signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

12. The method of claim 11, further comprising the steps of opening the exhalation valve, delivering an idle flow, and



monitoring flow and pressure to determine whether a condition indicating abatement of occlusion of the patient tubing system has occurred.

13. The method of claim 11, wherein said ventilator system includes a pressure control valve and a safety valve, and breath support is flow triggered, and further comprising the steps of a shut-down phase of closing the pressure control valve, controlling the exhalation valve to maintain patient end expiratory pressure at approximately zero, discontinuing flow triggering, setting the patient end expiratory pressure equal to zero, setting the breathing gas mix to contain 100 percent oxygen, and opening the safety valve.

14. The method of claim 13, further comprising the step of initiating the resumption of flow of breathing gas to the patient tubing system during an inspiratory phase of a breath cycle if a condition indicating abatement of occlusion of the patient tubing system has occurred.

15. The method of claim 13, wherein said tubing system includes an inhalation line, and further comprising the steps of sensing inspiratory pressure in said inhalation line, maintaining said shut-down phase until inspiratory pressure is less than or equal to 5 $cmH_2O$ or until 15 seconds have elapsed, whichever occurs first; initiating an inspiration phase, in which at the beginning the ventilator closes the safety valve, waiting a predetermined interval of time to allow for the safety valve to close, delivering a Pressure Controlled Ventilation based breath with an inspiratory pressure target of approximately 15 $cmH_2O$; initiating a first exhalation phase, in which the ventilator closes the pressure control valve and controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero, until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; initiating a second exhalation phase, in which the ventilator closes the pressure control valve, controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero and opens the safety valve until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; and initiating an inspiration phase with mandatory breath settings while maintaining patient end expiratory pressure of approximately zero.

16. The method of claim 1, further comprising the step of generating an occlusion alarm signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

17. A system for detecting disconnection and occlusion of a patient tubing system of a pneumatically driven, electronically controlled ventilator system for providing breathing gas to a patient during the exhalation phase of a breath cycle, said exhalation phase having a plurality of control intervals, the system comprising:

means for delivering a flow of breathing gas to a patient during an inspiratory phase of a breath cycle;

means for determining an onset of an exhalation phase of said breath cycle;

means for suspending gas flow delivery to the patient tubing system during said exhalation phase of said breath cycle;

means for monitoring exhalation flow and pressure in the patient tubing system during a plurality of control intervals of said exhalation phase of said breath cycle to determine whether a condition indicating disconnection of the patient tubing system has occurred;

means for monitoring exhalation pressure in the patient tubing system during a plurality of control intervals of

said exhalation phase of said breath cycle to determine whether a condition indicating occlusion of the patient tubing system has occurred; and

means for generating a disconnection signal indicating disconnection of the patient tubing system responsive to said exhalation flow and said pressure in said patient tubing system if said condition indicating occlusion of the patient tubing system has not occurred, and if said condition indicating disconnection of the patient tubing system has occurred.

18. The system of claim 17, wherein said tubing system includes an exhalation line, and said means for monitoring exhalation flow and pressure in the patient tubing system comprises a pressure sensor connected to said exhalation line and a flow sensor connected to said exhalation line, and means for declaring disconnection of the patient tubing system has occurred if, during a control interval, the pressure in the exhalation line is less than or greater than a predetermined pressure range, and if exhalation flow is less than a predetermined flow threshold, for a contiguous period of consecutive control intervals within a predetermined initial period of time following onset of an exhalation phase.

19. The system of claim 17, wherein said tubing system includes an exhalation line, and said means for monitoring exhalation flow and pressure in the patient tubing system comprises a pressure sensor connected to said exhalation line and a flow sensor connected to said exhalation line, and means for declaring disconnection of the patient tubing system has occurred if, during a control interval, the pressure in the exhalation line is less than or greater than a predetermined pressure range, and if exhalation flow is less than a disconnection flow limit threshold based upon a flow target and a predetermined disconnection sensitivity, for a contiguous period of consecutive control intervals within a predetermined initial period of time following onset of an exhalation phase.

20. The system of claim 17, wherein said tubing system includes an exhalation line, and said means for monitoring exhalation flow and pressure in the patient tubing system comprises a flow sensor connected to said exhalation line, and means for declaring disconnection of the patient tubing system has occurred if a desired flow target is greater than or equal to a maximum flow threshold, and the duration of a current inspiration is greater than or equal to a maximum allowed spontaneous inspiration time.

21. The system of claim 17, wherein said tubing system includes an exhalation line, and said means for monitoring exhalation flow and pressure in the patient tubing system comprises a flow sensor connected to said exhalation line for measuring exhalation flow from the beginning of an inspiration to the beginning of an exhalation, means for determining an exhalation volume from the sensed flow from the beginning of the inspiration to the beginning of the exhalation, and means for declaring disconnection of the patient tubing system has occurred if the exhalation volume is less than the integral of the net flow from the beginning of inspiration to the beginning of exhalation with respect to time, multiplied by a proportional factor and a disconnection sensitivity factor, for three consecutive breaths.

22. The system of claim 17, wherein said tubing system includes an exhalation line and an inhalation line, and wherein said means for monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises a pressure sensor connected to said exhalation line, a pressure sensor connected to said inhalation line, a comparator for determining a pressure drop by



comparing pressure in said exhalation line and pressure in said inhalation line, and means for generating an alarm indicating occlusion if said pressure drop exceeds a predetermined pressure drop threshold.

23. The system of claim 22, further including means for adjusting said pressure drop for a pressure offset and a gain drift.

24. The system of claim 22, wherein said ventilator system includes a plurality of counters, each of said counters having a different limit corresponding to a different respective pressure drop range, said means for monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprising a comparator for comparing said pressure drop and said pressure drop threshold in a plurality of consecutive control intervals, means for incrementing each of said plurality of counters if the pressure drop is greater than the corresponding pressure range of the plurality of counters, respectively, and means for generating an alarm if the respective limits of any of said plurality of counters are exceeded.

25. The system of claim 17, wherein said control intervals have a predetermined duration.

26. The system of claim 17, wherein said tubing system includes an exhalation compartment, and wherein said means for monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises a pressure sensor for measuring pressure in said exhalation compartment, and means for generating an alarm indicating occlusion if said pressure in said exhalation compartment exceeds a predetermined exhaust port threshold pressure for a predetermined number of consecutive control intervals within a predetermined period of time during an exhalation phase.

27. The system of claim 17, further comprising means for generating an occlusion signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

28. The system of claim 27, further comprising means for opening the exhalation valve, means for delivering an idle flow, and means for monitoring flow and pressure to determine whether a condition indicating abatement of occlusion of the patient tubing system has occurred.

29. The system of claim 27, wherein said ventilator system includes a pressure control valve, a safety valve, and means for flow triggering breath support, and further comprising shut-down phase means for closing the pressure control valve, controlling the exhalation valve to maintain patient end expiratory pressure at approximately zero, discontinuing flow triggering, setting the patient end expiratory pressure equal to zero, setting the breathing gas mix to contain 100 percent oxygen, and opening the safety valve.

30. The system of claim 29, further comprising means for initiating a resumption of flow of breathing gas to the patient tubing system during an inspiratory phase of a breath cycle if a condition indicating abatement of occlusion of the patient tubing system has occurred.

31. The system of claim 29, wherein said tubing system includes an inhalation line, and further comprising occlusion status cycling means for sensing inspiratory pressure in said inhalation line, maintaining said shut-down phase until inspiratory pressure is less than or equal to 5 $cmH_2O$ or until 15 seconds have elapsed, whichever occurs first; initiating an inspiration phase, in which at the beginning the ventilator closes the safety valve, waiting a predetermined interval of time to allow for the safety valve to close, delivering a

Pressure Controlled Ventilation based breath with an inspiratory pressure target of approximately 15 $cmH_2O$; initiating a first exhalation phase, in which the ventilator closes the pressure control valve and controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero, until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; initiating a second exhalation phase, in which the ventilator closes the pressure control valve, controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero and opens the safety valve until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; and initiating an inspiration phase with mandatory breath settings while maintaining patient end expiratory pressure of approximately zero.

32. The system of claim 17, further comprising means for generating an occlusion alarm signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

33. A method for detecting occlusion of a patient tubing system of a pneumatically driven, electronically controlled ventilator system for providing breathing gas to a patient during the exhalation phase of a breath cycle, said exhalation phase having a plurality of control intervals, comprising the steps of:

delivering a flow of breathing gas to a patient during an inspiratory phase of a breath cycle;

determining an onset of an exhalation phase of said breath cycle;

suspending gas flow delivery to the patient tubing system during said exhalation phase of said breath cycle;

monitoring exhalation pressure in the patient tubing system during a plurality of control intervals of said exhalation phase of said breath cycle to determine whether a condition indicating occlusion of the patient tubing system has occurred; and

generating a occlusion signal indicating occlusion of the patient tubing system responsive to said pressure in said patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

34. The method of claim 33, wherein said tubing system includes an exhalation line and an inhalation line, and wherein said step of monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises sensing pressure in said exhalation line, sensing pressure in said inhalation line, determining a pressure drop by comparing pressure in said exhalation line and pressure in said inhalation line, and generating an alarm indicating occlusion if said pressure drop exceeds a predetermined pressure drop threshold.

35. The method of claim 34, further including the step of adjusting said pressure drop for a pressure offset and a gain drift.

36. The method of claim 34, wherein said ventilator system includes a plurality of counters, each of said counters having a different limit corresponding to a different respective pressure drop range, said step of monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprising comparing said pressure drop and said pressure drop threshold in a plurality of consecutive control intervals, and incrementing each of said plurality of



counters if the pressure drop is greater than the corresponding pressure range of the plurality of counters, respectively, and generating an alarm if the respective limits of any of said plurality of counters are exceeded.

37. The method of claim 33, wherein said control intervals have a predetermined duration.

38. The method of claim 33, wherein said tubing system includes an exhalation compartment, and wherein said step of monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises sensing pressure in said exhalation compartment, and generating an alarm indicating occlusion if said pressure in said exhalation compartment exceeds a predetermined exhaust port threshold pressure for a predetermined number of consecutive control intervals within a predetermined period of time during an exhalation phase.

39. The method of claim 33, further comprising the step of generating an occlusion signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

40. The method of claim 39, further comprising the steps of opening the exhalation valve, delivering an idle flow, and monitoring flow and pressure to determine whether a condition indicating abatement of occlusion of the patient tubing system has occurred.

41. The method of claim 39, wherein said ventilator system includes a pressure control valve and a safety valve, and breath support is flow triggered, and further comprising the steps of a shut-down phase of closing the pressure control valve, controlling the exhalation valve to maintain patient end expiratory pressure at approximately zero, discontinuing flow triggering, setting the patient end expiratory pressure equal to zero, setting the breathing gas mix to contain 100 percent oxygen, and opening the safety valve.

42. The method of claim 41, further comprising the step of initiating resumption of flow of breathing gas to the patient tubing system during an inspiratory phase of a breath cycle if a condition indicating abatement of occlusion of the patient tubing system has occurred.

43. The method of claim 41, wherein said tubing system includes an inhalation line, and further comprising the steps of sensing inspiratory pressure in said inhalation line, maintaining said shut-down phase until inspiratory pressure is less than or equal to 5 $cmH_2O$ or until 15 seconds have elapsed, whichever occurs first; initiating an inspiration phase, in which at the beginning the ventilator closes the safety valve, waiting a predetermined interval of time to allow for the safety valve to close, delivering a Pressure Controlled Ventilation based breath with an inspiratory pressure target of approximately 15 $cmH_2O$; initiating a first exhalation phase, in which the ventilator closes the pressure control valve and controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero, until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; initiating a second exhalation phase, in which the ventilator closes the pressure control valve, controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero and opens the safety valve until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; and initiating an inspiration phase with mandatory breath settings while maintaining patient end expiratory pressure of approximately zero.

44. The method of claim 33, further comprising the step of generating an occlusion alarm signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

45. A system for detecting occlusion of a patient tubing system of a pneumatically driven, electronically controlled ventilator system for providing breathing gas to a patient during the exhalation phase of a breath cycle, said exhalation phase having a plurality of control intervals, each of said control intervals having a predetermined duration, the system comprising:

means for delivering a flow of breathing gas to a patient during an inspiratory phase of a breath cycle;

means for determining an onset of an exhalation phase of said breath cycle;

means for suspending gas flow delivery to the patient tubing system during said exhalation phase of said breath cycle;

means for monitoring exhalation pressure in the patient tubing system during a plurality of control intervals of said exhalation phase of said breath cycle to determine whether a condition indicating occlusion of the patient tubing system has occurred; and

means for generating an occlusion signal indicating occlusion of the patient tubing system responsive to said pressure in said patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

46. The system of claim 45, wherein said tubing system includes an exhalation line and an inhalation line, and wherein said means for monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises a pressure sensor connected to said exhalation line, a pressure sensor connected to said inhalation line, a comparator for determining a pressure drop by comparing pressure in said exhalation line and pressure in said inhalation line, and means for generating an alarm indicating occlusion if said pressure drop exceeds a predetermined pressure drop threshold.

47. The system of claim 46, further including means for adjusting said pressure drop for a pressure offset and a gain drift.

48. The system of claim 46, wherein said ventilator system includes a plurality of counters, each of said counters having a different limit corresponding to a different respective pressure drop range, said means for monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprising a comparator for comparing said pressure drop and said pressure drop threshold in a plurality of consecutive control intervals, means for incrementing each of said plurality of counters if the pressure drop is greater than the corresponding pressure range of the plurality of counters, respectively, and means for generating an alarm if the respective limits of any of said plurality of counters are exceeded.

49. The system of claim 45, wherein said tubing system includes an exhalation compartment, and wherein said means for monitoring exhalation pressure in the patient tubing system to determine whether a condition indicating occlusion of the patient tubing system has occurred comprises a pressure sensor for measuring pressure in said exhalation compartment, and means for generating an alarm indicating occlusion if said pressure in said exhalation compartment exceeds a predetermined exhaust port threshold pressure for a predetermined number of consecutive control intervals within a predetermined period of time during an exhalation phase.



50. The system of claim 45, further comprising means for generating an occlusion signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

51. The system of claim 50, further comprising means for opening the exhalation valve, means for delivering an idle flow, and means for monitoring flow and pressure to determine whether a condition indicating abatement of occlusion of the patient tubing system has occurred.

52. The system of claim 50, wherein said ventilator system includes a pressure control valve, a safety valve, and means for flow triggering breath support, and further comprising shut-down phase means for closing the pressure control valve, controlling the exhalation valve to maintain patient end expiratory pressure at approximately zero, discontinuing flow triggering, setting the patient end expiratory pressure equal to zero, setting the breathing gas mix to contain 100 percent oxygen, and opening the safety valve.

53. The system of claim 52, further comprising means for initiating a resumption of flow of breathing gas to the patient tubing system during an inspiratory phase of a breath cycle if a condition indicating abatement of occlusion of the patient tubing system has occurred.

54. The system of claim 52, wherein said tubing system includes an inhalation line, and further comprising occlusion status cycling means for sensing inspiratory pressure in said inhalation line, maintaining said shut-down phase until inspiratory pressure is less than or equal to 5 $cmH_2O$ or until 15 seconds have elapsed, whichever occurs first; initiating an inspiration phase, in which at the beginning the ventilator closes the safety valve, waiting a predetermined interval of time to allow for the safety valve to close, delivering a Pressure Controlled Ventilation based breath with an inspiratory pressure target of approximately 15 $cmH_2O$; initiating a first exhalation phase, in which the ventilator closes the pressure control valve and controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero, until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; initiating a second exhalation phase, in which the ventilator closes the pressure control valve, controls the exhalation valve to maintain a patient end expiratory pressure of approximately zero and opens the safety valve until the inspiratory pressure is less than or equal to 5 $cmH_2O$ and at least 2.5 sec have passed, or a total of 5 seconds have elapsed since the beginning of the first exhalation phase; and initiating an inspiration phase with mandatory breath settings while maintaining patient end expiratory pressure of approximately zero.

55. The system of claim 45, further comprising means for generating an occlusion alarm signal indicating occlusion of the patient tubing system if said condition indicating occlusion of the patient tubing system has occurred.

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